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Water Pollution, Sources, Effect on Human Health and Treatment Technologies

Ekram Sabah Sahib Al Saidi [1*] Noor Haider Al-Taei [2], Wafaa Razzaq Hilal [3] Zainab Hamzah Muttaleb[4]

[1,2,3] Department of Environmental health, College of Applied Medical Science, University of Kerbala,
[4]Department of Environmental, College of Environmental sciences, Al-Qasim Green University
akram.s@uokerbala.edu.iq Karbala, Iraq noor.haider@uokerbala.edu.iq , Karbala, Iraq
wafaa.hilal@uokerbala.edu.iq , Karbala, Iraq, aliww1932016@gmail.com ,Babylon,Iraq

***Corresponding author email:** akram.s@uokerbala.edu.iq

تلوث المياه ومصادرها وتأثيرها على صحة الانسان وطرق معالجتها

اكرام صباح صاحب [1*]، نور حيدر يونس [2]، وفاء رزاق هلال[3]، زينب حمزة مطلب [4]

[1,2,3] قسم الصحة البيئية، كلية العلوم الطبية التطبيقية

[4] قسم البيئة، كلية علوم البيئة، جامعة القاسم الخضراء

akram.s@uokerbala.edu.iq, كربلاء , العراق

noor.haider@uokerbala.edu.iq , كربلاء, العراق

wafaa.hilal@uokerbala.edu.iq, كربلاء, العراق

aliww1932016@gmail.com , بابل , العراق

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ABSTRACT

Water represents the most important and main component on the surface of our planet. It is a basic and essential necessity for all living things on Earth, including humans. As a result, water that humans drink needs to be safe, readily available, sufficient, and uncontaminated. Moreover, water pollution is a severe environmental problem that jeopardizes ecological sustainability, human health, and economic development. Due to natural and human activities, water has become contaminated with various types of polluted. Water pollution by factories, agriculture, and sewage can it make it unfit for human use and is harmful to the environment and causes negative impact on human health because it contains organic and inorganic pollutants. Therefore, humans must work to maintain water quality and treat polluted water. The present review aims to identify water pollution through the use of biological, chemical, and physical indicators. It also classifies water pollution according to their many sources, origins, and effects on human health. Additionally, a brief discussion on different technological used to treat water pollutant.

Keywords: Water pollution; Water quality; Sources of water pollution; Impact, Treatment.

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INTRODUCTION

Water is considered one of the basic resources of life and it is the most important element on earth because it provides the basic conditions for the emergence of life [1, 2]. It is an indispensable fortune of the renewable treasury for all organisms inhabiting our planet. As well as, it significant for food output, economic concrescence, and public welfare. every cell in an organism requirement water to assignment normally. The Earth's surface is covered by water by 71%, with freshwater creating 3% and oceans and other big bodies of water accounting for 97%. In addition , aquifers comprise 1.6% of the water underground, and clouds, rain, and atmospheric vapor make up 0.001 (figure 1 and 2) [3,4].It is worth noting that many sources of surface water and groundwater are considered the main source for many different industries and activities in our country, including forestry, fisheries, hydropower, agriculture, cattle production, navigation, and recreation [5].

The rapid growth of industries and individuals are a worry when it comes to clean drinking water pollution. As a result, having access to clean water is still seen as one of humanity's most essential needs and a significant worldwide concern in the twenty-first century [6]. Many pollutants, once they enter water bodies, can change the smell, color and physical properties of the water. For example, heavy metals, even if they are in very small quantities, can pollute the water and thus harm the environment and the living organisms in it [7,8]. In addition, water contamination causes illnesses and fatalities all across the world; daily, it claims the lives of almost 14,000 people [9, 10].Therefore , the main goals of this study are to shed light on the sources of water pollution and the impact of different water pollutants as well as identify the technologies that can be utilized to purify water for a variety of uses.

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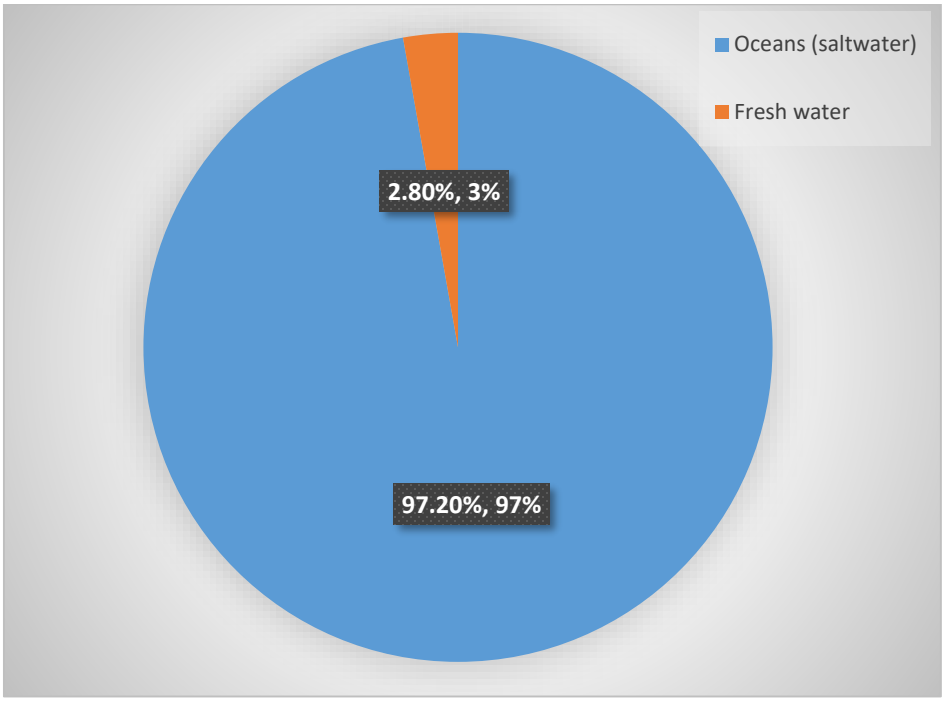

Figure 1: Earth's total water supply [3,4]

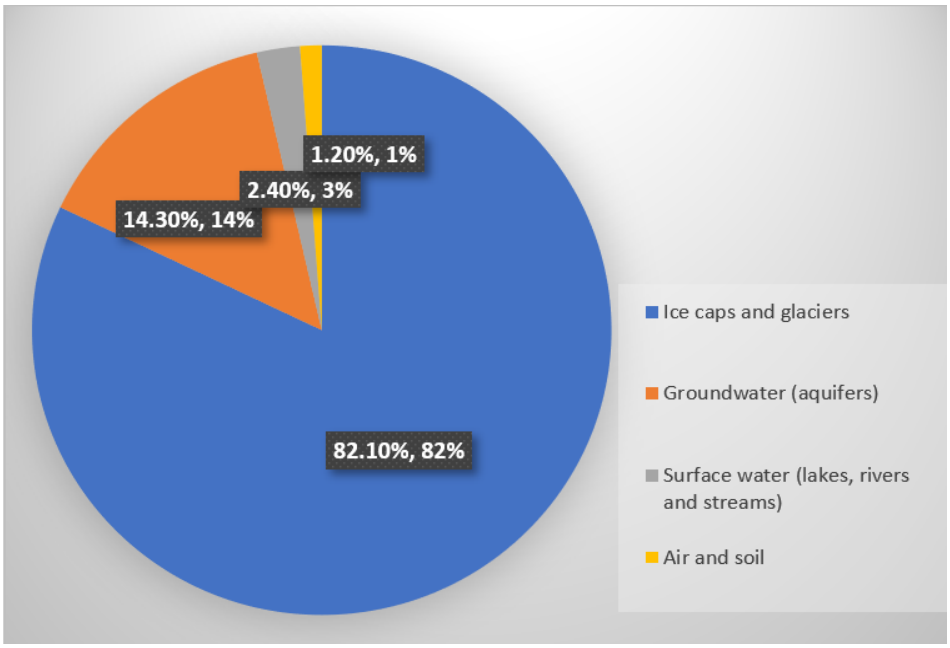

Figure 2: Freshwater resources on Earth [3,4]

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Origin of Water Pollution

Pollutants present on the Earth's surface can be of natural or man-made origin. Polluting chemicals including pesticide compounds, surfactants, plastics, and petrochemicals are man-made [2]. Many pollutants and particulates such as radioactive materials, hydrocarbons, nitrogen oxides, and heavy metals can occur naturally in the environment and form part of the environmental background exposure levels excreted or detoxified by organisms [12] .

Common sources of water contamination including those that are from natural to man-made, involving the drainage of industrial and home wastewater as well as agricultural and domestic garbage. Common entry points for natural pollutants into water reservoirs are storms and dust, subterranean rocks and volcanoes, vegetation cover, and rain [13,14].

Indicators of Water quality

Water quality is defined as the physical, chemical and biological properties of water.it represents the measure of the suitability of water for a specific use in relation to human needs or even in relation to the requirements of different animal or aquatic species according to the biological, chemical and physical characteristics of water quality. If appropriate standards are upheld, water quality guarantees the health and functionality of end users. There are several pollutants that each user has a concentration threshold for, beyond which using low-quality water will have negative consequences [15].

Table 1 :Types of water quality parameters [16].

Physical parameter	Chemical parameter	Biological parameter
Temperature	PH	Bacteria
Color	Hardness	Viruses
Taste and smell	Acidity and Alkalinity	Protozoa
Electrical conductivity EC	Chloride, sulfate, nitrogen and fluoride	Algae
Turbidity	Iron and manganese	
Solids	Copper and zinc	
	Dissolved oxygen	
	COD	
	BOD	
	Toxic inorganic and organic substances	
	Radioactive substances	

Sources of Water pollution

Figure 3 shows point and non-point causes of water contamination

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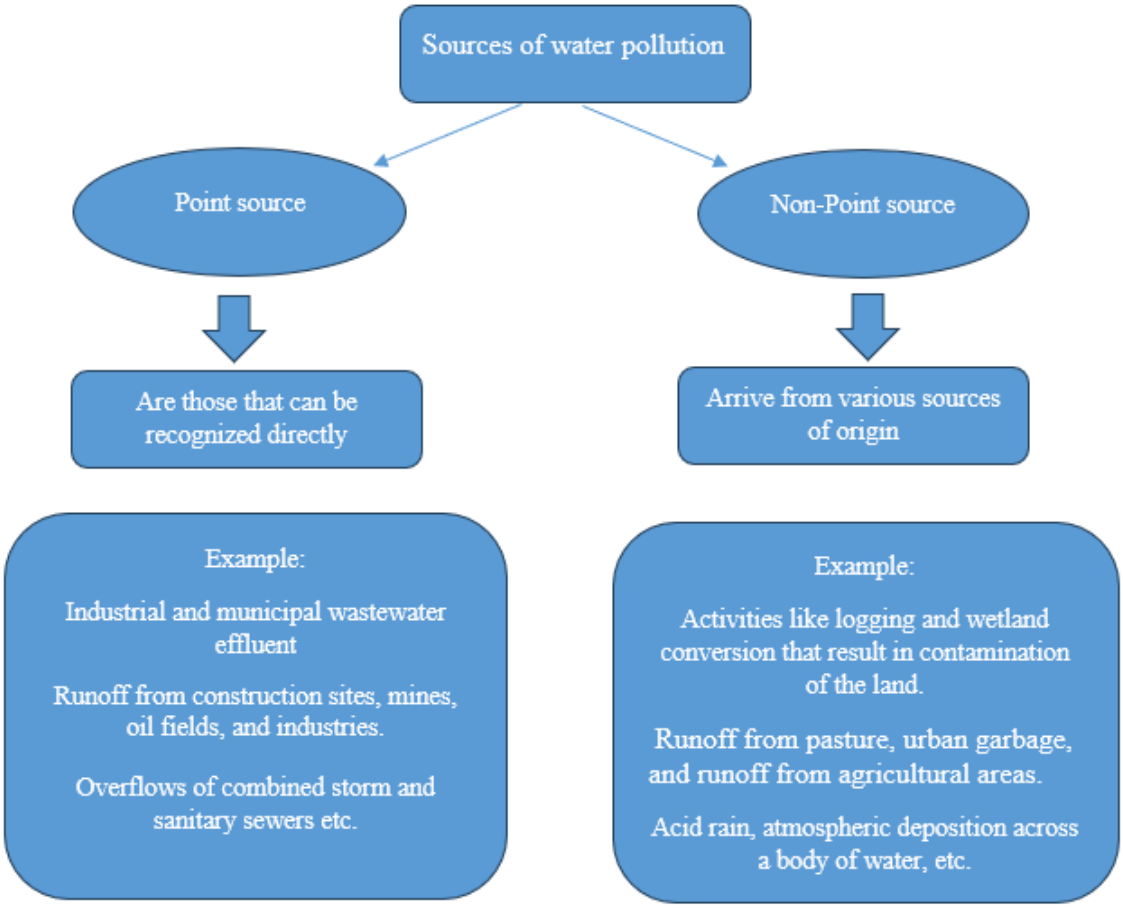

Figure 3: illustrated both point and non-point sources of water pollution [5], [17], [18]

Natural Sources

Pollutants can enter water reservoirs through several natural sources, including rainwater, volcanic rocks at the bottom of bodies of water, ground rocks, storms, dust, or even natural water flow. It is also worth noting that the airport is considered the natural and very important sources of water pollution because it removes particles and pollutants suspended in the air [13]. Additionally , the existences of bedrocks and volcanic below the water bodies may also be the source of certain types of salts[19].

Domestic Sewage

Domestic sewage is largely made of the public's waterborne waste, which is 99% water and 1% solids. Seventy percent of the particles in sewage are organic; thirty percent are inorganic. Of the organic components, 65% are proteins; carbohydrates account for 25%; and fat

makes 10%. Moreover, inorganic component of sewage derived from salt, sand and metals in various ratios. Apart from organic pollution, which causes oxygen depletion and kills fish, the generation of odors and the development of digestive infections are regarded among the most crucial issues related with wastewater [20].Many of the detergents and washing powders currently available that are manufactured through petrochemical factories contain many sources of phosphates that soften the water, which also cause harm and pollution to the water and to the living organisms present in the water [3,20].

Agricultural Wastes

Waste that comes primarily from runoff from livestock farms and cultivation arenas is referred to as agricultural waste. These days, farmers utilize a variety of agrochemicals to encourage the development of fruits and vegetables, which leads to a host of pollution issues. Additionally, it can poison aquatic organisms [21], [22].

Pesticides are utilized in contemporary agriculture in many nations. However, environmental monitoring shows that surface and subsurface water bodies contain trace pesticides even far from pesticide application sites[23].Nitrogen fertilizers may harm the ecology in intensifying agricultural regions. The main reason for the high percentage of nitrates in groundwater, drinking water sources is due to the increase in nitrate concentration in groundwater , which in extremely young children can result in methemoglobinemia, the potentially fatal "blue baby" syndrome [24]. To control pests in the soil or land, some pesticides are applied directly on soil. Using this method could lead to pesticides leaking into groundwater or surface runoff [3].

The industrial Waste

Considered the main source of water pollution is industry, as there are many pollutants emitted from industries that contribute to water pollution and make the water unsuitable for use. Among these important industries are, for example, energy supply , the food industry, building , mining, and production process[25]. Waste generated from industrial is rich in organic matter and ,the nature of industrial waste changes over time and between industries depending on the use, type of raw material, numerous processes, operational variables and other factors [26].

Gaseous, liquid and solid pollutants are emitted from various industries during transportation or use, for example in homes, agriculture and industrial products, and these pollutants can reach surface or groundwater. These wastes contain decomposable or refractory compounds that may be organic or inorganic and getting cause undesirable impact to the environment [27,28] .

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Acid rain pollution

Acid rain can change the pH surrounding plants and thus lead to damage to the lant and even its death. As a result of various human activities such as burning fossil fuels and volcanic eruptions, many compounds such as sulfur dioxide and nitrogen dioxide are generated in the atmosphere, and when these compounds combine with gases contained in the air, such as oxygen and hydrogen, sulfuric acids and nitric acids will form, which in turn will fall with rain and snowfall, causing this acid rain to fall and causing harm to the environment and water**.** When acid rain enters the earth, it enters streams and transports its acidic substances into bodies of water. Acid rain that accumulates in aquatic habitats depletes the pH of the water and has an impact on the aquatic biota [29].

Thermal Pollution

Water temperature varies due to thermal pollution. The thermal power station discharge raised water temperature by 10 Celsius. Thus, heat pollution harms aquatic life. Solar and wind power are replacing thermal energy. Plantations lower thermal pollution and CO2 [13,30].

Radioactive waste

Water contamination by radioactive compounds causes pollution [5]. Radioactive elements dissolve in surface water, making the Earth's crust a natural supply. Human-made radioactive sources include nuclear weapons, power plants, and industry. Radioactivity's long-term environmental effects rely on elemental half-life [31]. After weathering and erosion, long-term geological deposition exposes all elements, especially radioactive minerals, to geological agents, mobilizing them. Groundwater's lowest radioactive element level depends on local geology and strata [32]. One of the most important natural radioactive elements that may be present in drinking water is the radioactive element radon, uranium, and radium, in addition to the radionuclides of the uranium, aluminum, and thorium series. All of these radioactive pollutants have a significant and harmful effect on the human body and may cause bone cancer and many other health risks [12,33] .

Oil spillage

The 1990s saw a considerable rise in the potential for offshore oil and gas production because to the global increase in demand for these resources and the depletion of onshore reserves. Oil transportation technology progressed with oil production, resulting in supertankers and pipelines that carry crude and processed oil across seas. Oil spills from offshore oil production and transportation harm marine ecosystems, affecting the environment, society, and economy. These consequences may endure for years [34]. Oil spills from gasoline, diesel, and derivative cargo vessels pollute the seas. Additionally, offshore oil exploration pollutes water [35].

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Water pollution effects on human health

Water borne disease

Pathogens present in water polluted with infected feces, urine, discharges, and tissues are what cause water-borne illnesses [36]. By consuming contaminated food or water owing to poor sanitation and sewage management, the fecal-oral route transmits most waterborne infections [37]. Aquatic infections usually cause diarrhea. Excessive stooling may cause dehydration and death. Diarrhea kills 1.8 million people yearly and accounts for 4.1% of the worldwide disease burden, according to the WHO. According to additional estimates, 88% of that load is related to contaminated water supplies, poor sanitation, and poor hygiene, with the majority of the burden falling on children in poorer nations [38,39].

Feces may cause contamination of drinking water, and contamination levels may vary from one form to another or may not occur. People in low-contamination cultures may have used the same source for years without harming their health. In high-contamination locations, tourists, the young, the elderly, and people with immunodeficiency-related conditions may be more prone to become sick[37].

Waterborne sickness may develop from intestinal parasites, bacteria, viruses, and protozoa. Cholera, amoebic dysentery, bacillary dysentery (shigellosis), cryptosporidiosis, typhoid, giardiasis, paratyphoid, balantidiasis, salmonellosis, Campylobacter enteritis, rotavirus diarrhea, *E. coli* diarrhea, hepatitis A, leptospirosis, and poliomyelitis are waterborne disease outbreak organisms[36], [40]

Chemicals in water that affect human health

Arsenic is a widely distributed metalloid that can be found in soil, rock, water, and the atmosphere. Many nations across the world have groundwater used for drinking that contains inorganic arsenic. The process of liquefaction and fusion of metals, in addition to the generation of energy from fossil fuels, are the two main industrial processes through which soil and water are contaminated with arsenic [32,41].In controlled research conducted in northern Chile including patients with lung cancer and a frequency-matched hospital between 1994 and 1996, arsenic levels in drinking water were found to have a strong correlation with lung cancer. Research has also demonstrated a combined effect of drinking water contaminated with arsenic and smoking on the development of lung cancer. High drinking water arsenic levels have also been connected to liver cancer development; nevertheless, at levels below 0.64 mg/L[14] , this impact was not statistically significant.

The drinking water supply is tainted with lead due to fittings, pipelines, solder, and home plumbing systems[5]. Because it can impair the central and peripheral nerve systems and induce cardiovascular disorders, lead is a teratogen that is not biodegradable. Lead poisoning, or mercury toxicity, can manifest as either acute or chronic. Acute contact can induce nausea,

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vomiting, headaches, dizziness, renal malfunction, abdominal discomfort, fatigue, sleeplessness, arthritic pain, and hallucinations. Continuous exposure to lead through various means can lead to many diseases, such as mental disability, birth defects, hyperactivity, paralysis, and damage to the brain, kidneys, and muscles, and can ultimately lead to death [32].

Nitrates are considered one of the most dangerous pollutants that are closely linked to malignant tumors that occur in many people, especially rectal and colon cancer. A study conducted in East Azerbaijan proved that there is a close relationship and connection between nitrates and colon cancer in men. Tumours caused by nitrates depend on their concentration. Drinking water levels higher than 3.87 mg/L greatly increase the risk; much below the current 50 mg/L guideline. Therefore, the greater the amount of nitrates (above the normal level specified by the World Health Ministry) consumed and present in the water, the greater the susceptibility to developing rectal and colon cancer [42].

Minerals found in rocks naturally contain chromium, which is also highly persistent in aqueous sediments. There are two oxidation states for chromium: $^{+}3$ and $^{+}6$. Because of its high adsorption rate, Cr ($^{+}6$) is more hazardous than Cr ($^{+}3$) [43] . Cr is more abundant in ultramafic igneous rocks. Laterite remains beneath ultramafic rocks have abundant chromite. Cr is found in metal alloys, magnetic tapes, paint pigments, wood preservatives, rubber, cement, paper, metal plating, and shielding metal coatings [44]. Drinking high-chromium water exposes populations to hexavalent chromium carcinogenicity. Hexavalent chromium may create issues, according to research on drinking water and respiratory system cancer [45]. Changhua County, Taiwan, similarly linked elevated chromium contamination to stomach cancer [46].

Smelters, battery manufacturers, thermometer manufacturers, fungicide manufacturers, and other sectors use mercury. The most well-known instance of mercury pollution in the waters occurred in 1938 when fish stocks in Minamata Bay were contaminated by a large mercury release from a Japanese factory. It took a few years for its effects to manifest. By then, a large number of locals had consumed the fish, and about 2000 of them had become poisoned. Hundreds of people had died, and the cause of death was identified as "Minamata disease," which was brought on by eating fish contaminated with methyl mercury. Humans suffer from brain impairment and genetic abnormalities as a result. Aquatic environments exhibit biological amplification in Mercury [47].

The most electronegative element in the entire chemical elemental family is fluoride. It is apt to produce an ion of fluoride in the solution. Due to its high reactivity, it can only be found in solid salt and ions in aqueous solutions[48] . Nearly all types of water contain fluoride, ranging from trace to high concentrations. The solubility of fluoride-bearing minerals, temperature, pH, and other variables all affect how much fluoride is in the water[49] . Fluoride-containing water prevents tooth decay and bone loss. Concentrations below 0.5 mg/l induce cavities and mottling,

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whereas exposure to levels over 0.5 mg/l for five to six years may harm health and develop fluorosis[50] .

Cadmium Cd is naturally found in ores collectively with Pb, Zn, and Cu. Due to cadmium is associated to cadmium minerals, cadmium in groundwater originates from cadmium mining [44] . When contaminated effluents irrigate soil, food crops grow and eventually come into contact with cadmium. Renal failure, kidney damage, and gastrointestinal disorders are caused by high concentrations of Cd [51,52]

Common methods for treating polluted

One of the main and common issues at the present time and in the future is the issue of combating all kinds of pollution, particularly water pollution, because it is considered one of the worrying problems at the present time because of its negative, health and environmental effects on all types of the environment and humans in particular. Many techniques have been developed in recent decades to eliminate water contaminate .Physical, chemical, and biological techniques that used to treat water , increasing the potential of water resources and lowering difficulties and worries associated with water pollution [33] figure 4 .

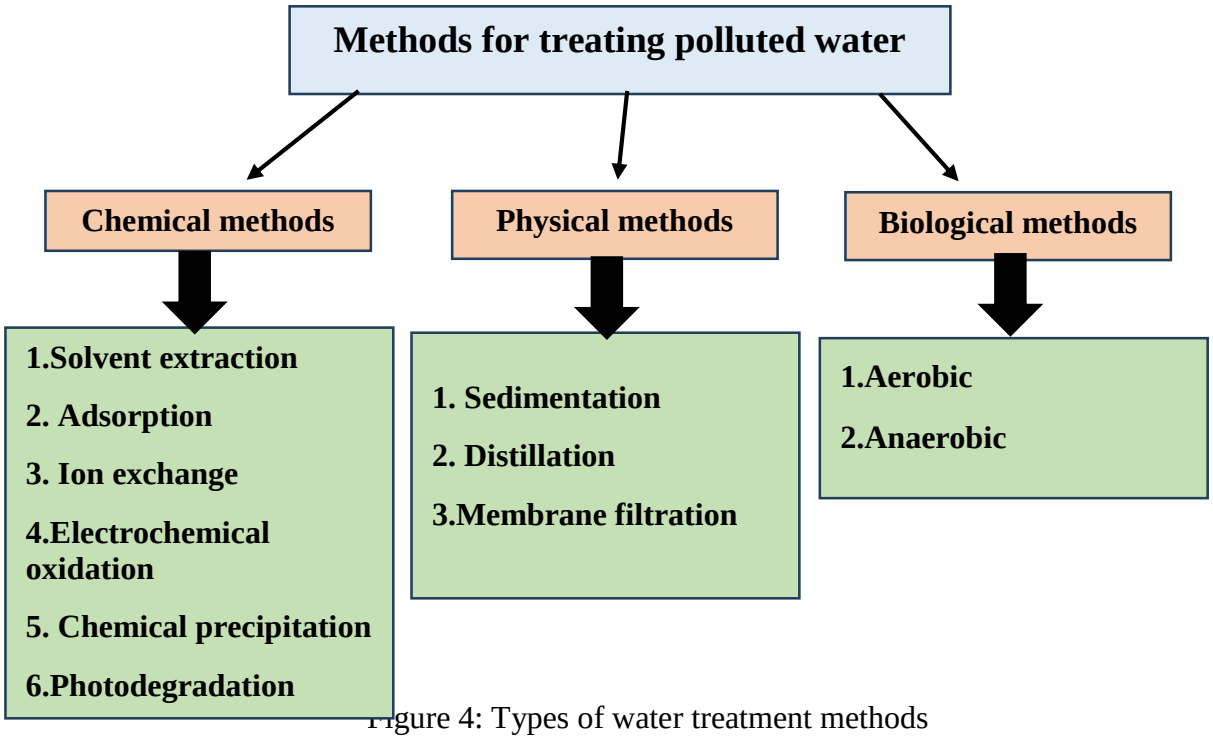

Figure 4: Types of water treatment methods

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Chemical methods

Solvent extraction

In the petrochemical sector, for example, extraction of solvents or extraction from liquid to liquid is employed to eliminate metal ions and aromatic chemicals from liquid forms. The basis for separation is the pollutant's relative solubility in two special immiscible or partly miscible solvents, usually two types of solvents, an organic solvent and polar solvents like water. Salts are moved using this technique from one polar solvent to another non-polar solvent or the other way around. The mining and chemical industries, as well as the processing of fermentation products like steroids, antibiotics, and amino acids, all make extensive use of the solvent extraction process[53].

Adsorption

One of the best techniques for eliminating harmful organic and mineral substances from contaminated waterways is adsorption. This approach has several advantages over others, such as its low cost, convenience of use, insensitivity to harmful contaminants, and simple design. Adsorption is a prevalent occurrence wherein the mechanism responsible for eliminating contaminants takes place on the absorbent's surface [54]. The process of adsorption causes molecules or particles to stick to a surface and create a thin layer of film[55] .Adsorption can take two forms: chemical, in which the adsorbent and adsorbate establish a covalent connection, or physical, in which weak Van der Waals forces are at work [55].

The pH of the aqueous solution, the adsorbent's quantity, time spent in contact, temperature and first concentration of pollutants, are all important factors in the adsorption of pollutants. Improving the elimination of pollutants can be greatly enhanced by optimizing these factors [56].

Electrochemical oxidation

In an electrochemical technique, reducing processes occurs at the cathode and reactions involving oxidation occur at the anode. The basic principle of electrochemical procedures is to remove pollutants by utilizing the redox reactions that take place at the anode (pollutant oxidation) and cathode (heavy metal reduction), which have been widely employed as a heavy metal remediation option. In the meantime, wastewater is being cleaned of organic [57,58].

Ion exchange

A reversible process termed ion exchange is employed for swapping out a liquid phase for an insoluble solid phase. A gel or crystalline structure might signify the solidified phase in the ion exchange operation. If the transferred ions are positively charged, it is termed a cation exchange; if the ionic species are negatively charged, it is termed an anion exchange [59]. Ion exchange has

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many benefits, including high removal efficiency and quick kinetics, which make it an effective technique for eliminating heavy metals from wastewater [60].

Chemical precipitation

One practical and easy-to-use way of treatment wastewater containing heavy metals is chemical precipitation. Historically, wastewater has been treated with strong alkaline reagents involving ammonia, lime, sodium hydroxide, sodium carbonate, and sodium sulfide to raise the pH so that soluble heavy metal ions change into their insoluble counterparts and precipitate in an alkaline environment [60].

Photodegradation

Photodegradation is a possibly crucial technology for eliminating pesticides, dyes, medicines, and organic substances from wastewater and water. Mostly, photolysis or photocatalytic oxidation drives this process. The process of photolysis occurs when contaminants that have been dissolved in water absorb visible or ultraviolet (UV) light. While pollutants are broken down through a process known photocatalytic oxidation, or photocatalysis, when they come into contact with hydroxyl radicals (OH) or other oxidants, photolysis is the result of radiation-induced photochemical reactions. Numerous benefits of this method include total mineralization of contaminants, ease of operation, and lack of chemical addition [61].

Physical methods

Sedimentation

Sedimentation, also referred to as clarifying, is one of the primary physical processes used as the first phase in water treatment technologies. Using gravitational force, it separates suspended particles like clay in water. The density, shape, and temperature of the water are some of the factors that influence how successful the sedimentation procedure is. Using this method cannot eliminate dissolved items, which includes microorganisms and both organic and inorganic pollutants. Water treatment frequently works combined with additional approaches, such as filtration, to maximize its overall effectiveness[62].

Distillation

The simplest and oldest way of treating water is probably distillation, which can remove many kinds of contaminants, germs, minerals, and organic molecules from water—with the exception of volatiles like acetone and ethanol. It removes undesirable materials and evaporates water using a heat source. By using this procedure, tainted water is brought to a boil and the resulting Water vapor is oriented towards a condenser for cooling, condenses, and is ultimately kept in storage. Many pollutants can be effectively disposed of with this technique,

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encompassing microbiological pollutants, iron and certain rare metals, nitrates, and mineral components including salt, magnesium, and lead [63].

Membrane filtration

Membrane filtration filters contaminants out of water depending on their size or charge employing a flexible, semipermeable membrane [55]. Reverse osmosis, microfiltration, ultrafiltration, nanofiltration, and other forms of membrane filtration techniques are categorized according to the size of particles they are able to remove. This technique works well to get rid of a differences of contaminants, such as bacteria, germs, and inorganic and organic chemicals [64]. Excellent efficacy is achieved in the handling of heavy metal wastewater by membrane filtration [60] .

Biological treatment

One of the greatest crucial techniques for handling and wastewater and water is biological treatment. Biological processes which can be anaerobic and aerobic have distinct characteristics from one another. The germs and microorganisms contained in chemical wastes are eliminated by using this technique without requiring of additional chemicals. These procedures, however, are insufficient for treating water and wastewater; other treatment techniques, such as chemical and physical treatment, are needed.

The types of bacteria or other microorganisms (such as algae and fungi) that contribute to the breakdown of contaminants in wastewater are correlated with the anaerobic (oxygen-free) and aerobic (oxygen-rich) conditions. Through biological processes, contaminants are removed in biological treatment procedures. At the core of the biological treatment process is the growth of microorganisms in wastewater. In a biological wastewater treatment system, the active population is a complicated concoction of microbes that are mutually dependent for development and nourishment [65,66].

CONCLUSION

This minireview concluded that water consumption increases as the world`s population increases. Preserving water from pollution is one of the most significant issues and water pollution is considered one of the problems that have a great resonance and constitute a continuing concern for many countries, given that water represents the main source of all vital and industrial processes that take place in various countries. Therefore, educating people about the seriousness of this matter and protecting the environment and water from pollution are extremely important matters in order to ensure the availability of a healthy and suitable environment for individuals and communities to live in.

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Conflict of interests.

There are non-conflicts of interest.

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الخلاصة

يمثل الماء أهم عنصر رئيسي على سطح كوكبنا، فهو ضرورة أساسية وضرورية لجميع الكائنات الحية على الأرض، بما في ذلك البشر. ونتيجة لذلك، يجب أن يكون الماء الذي يشربه البشر آمنًا ومتاحًا بسهولة وكافيًا وغير ملوث. علاوة على ذلك، فإن تلوث المياه يمثل مشكلة بيئية خطيرة تعرض الاستدامة البيئية وصحة الإنسان والتنمية الاقتصادية للخطر. بسبب الأنشطة الطبيعية والبشرية، أصبح الماء ملوثًا بأنواع مختلفة من الملوثات. تلوث المياه من المصانع والزراعة والصرف الصحي يمكن أن يجعلها غير صالحة للاستخدام البشري وتضر بالبيئة وتؤثر سلبًا على صحة الإنسان لأنها تحتوي على ملوثات عضوية وغير عضوية. لذلك، يجب على البشر العمل على الحفاظ على جودة المياه ومعالجة المياه الملوثة. تهدف هذه المراجعة إلى تحديد تلوث المياه من خلال استخدام المؤشرات البيولوجية والكيميائية والفيزيائية. كما تصنف ملوثات المياه وفقًا لمصادرها العديدة وأصولها وتأثيراتها على صحة الإنسان. بالإضافة إلى مناقشة موجزة حول التقنيات المختلفة المستخدمة لمعالجة ملوثات المياه.

الكلمات المفتاحية: تلوث المياه، جودة المياه، مصادر تلوث المياه، التأثير، المعالجة.

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